



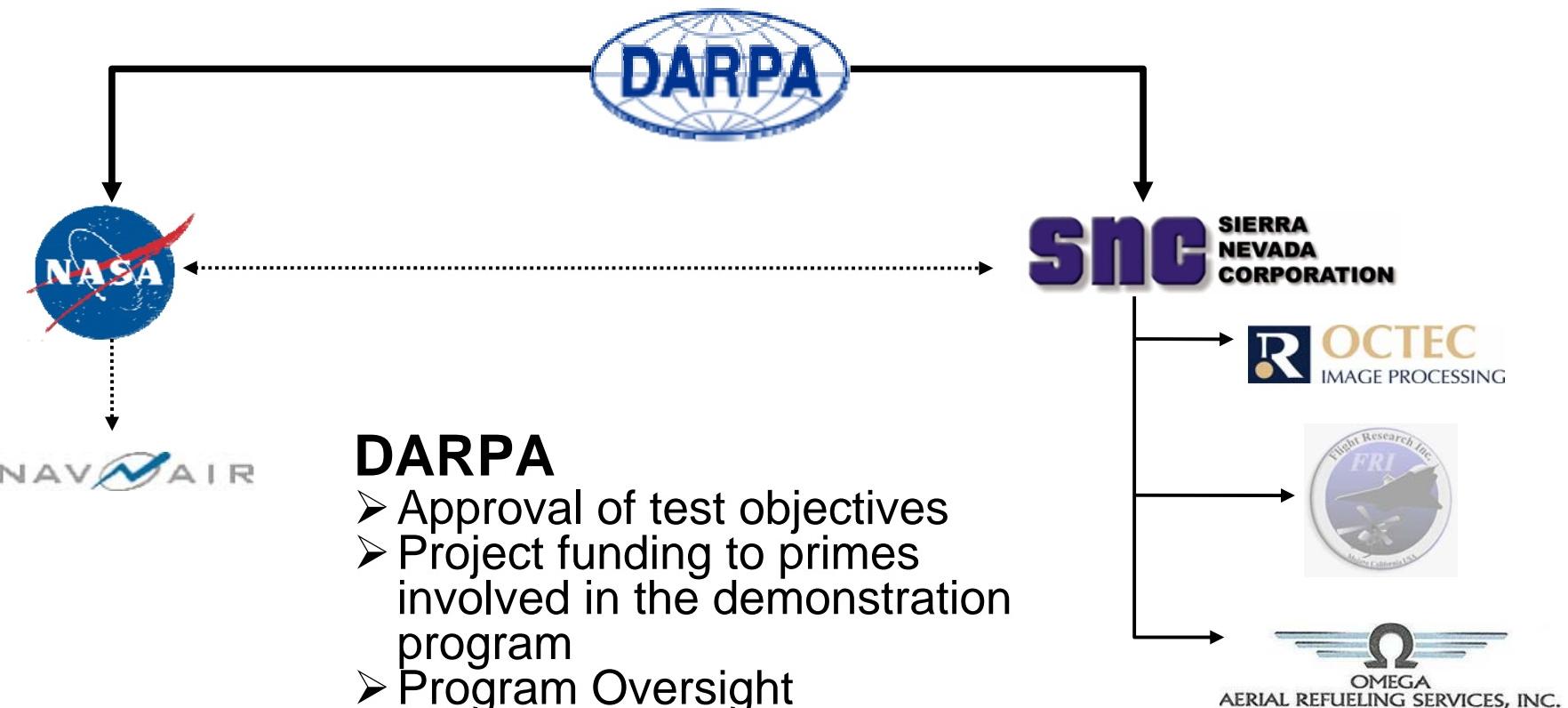
# AARD - Autonomous Airborne Refueling Demonstration



**Dick Ewers**  
DFRC, NASA

**East Coast  
SETP  
Symposium  
20 April 2007**





## DARPA

- Approval of test objectives
- Project funding to primes involved in the demonstration program
- Program Oversight

## DFRC

- Responsible Test organization
- Lead system integrator
- Responsible for system airworthiness
- Responsible for flight safety

## SNC Development Team

- Overall test leader
- AARD Controller development
- Responsible for mission success
- Responsible for contracting Omega tanker activities.
- Support integration, airworthiness and flight test activities.



# Program Goals

- **Primary Objective**
  - ⇒ To make one **fully automatic** probe-to-drogue engagement using the AARD system.
- **Success Criteria**
  - ⇒ One successful automatic engagement from the trail position (planned 100 ft from drogue) to basket connection
  - ⇒ Hold connected to simulate a complete refueling sequence (planned for 5 minutes) then automatically disconnect and return to trail
  - ⇒ Record on video – ( with Pilot's hands in the air!!)



- The Basket  
Can  
Strike Back



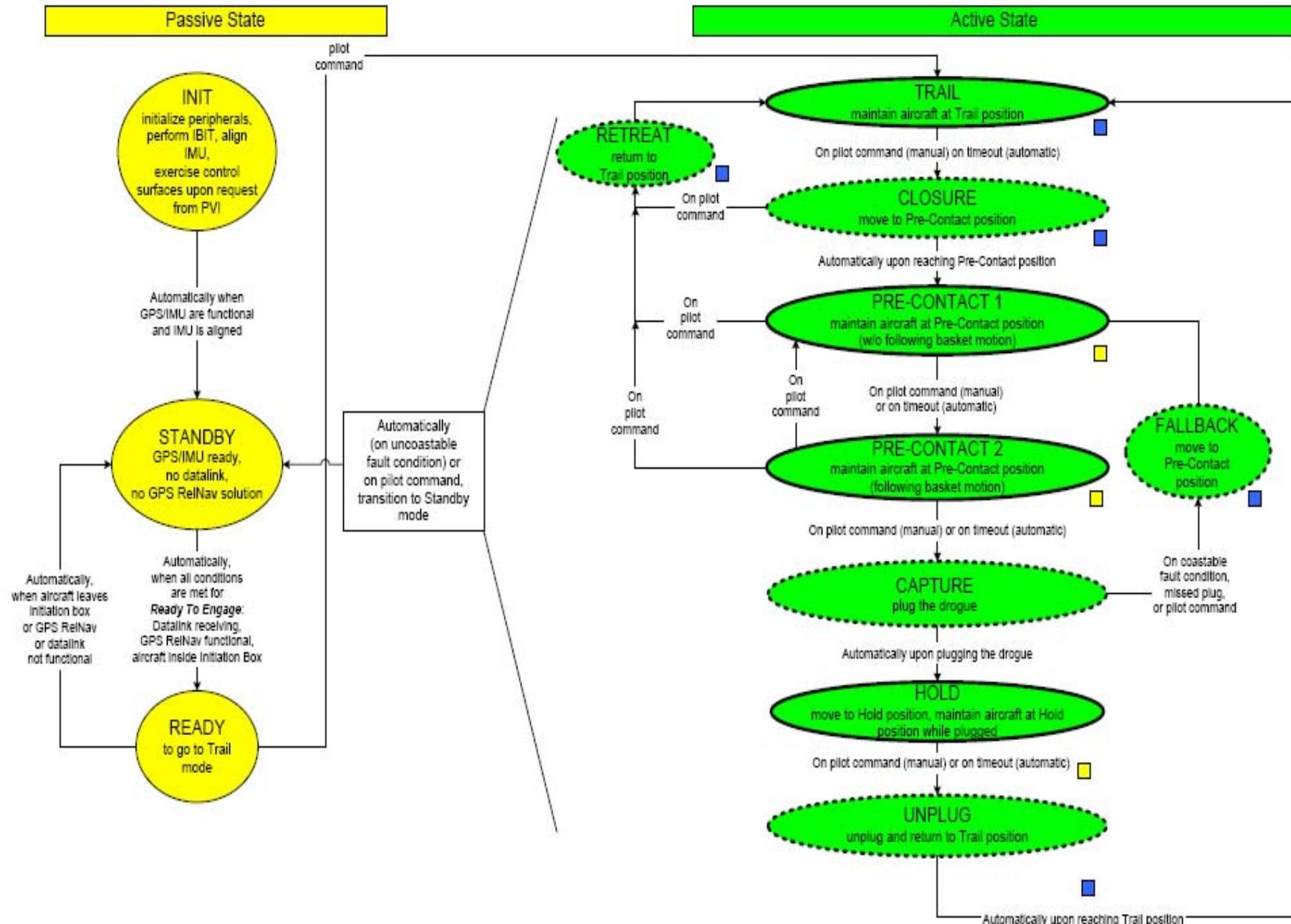


# System Design

- **Tanker System**
  - ⇒ GPS Pallet Transmitting Position & Velocity
  - ⇒ No Modifications to Drogue Refuel System
- **F/A-18 System**
  - ⇒ GPS & Receiver; “Rel-Nav” Solution
  - ⇒ Optical Tracker; Basket Capture Solution
  - ⇒ AARD Computer to Replace Pilot Inputs
  - ⇒ PVI Panel

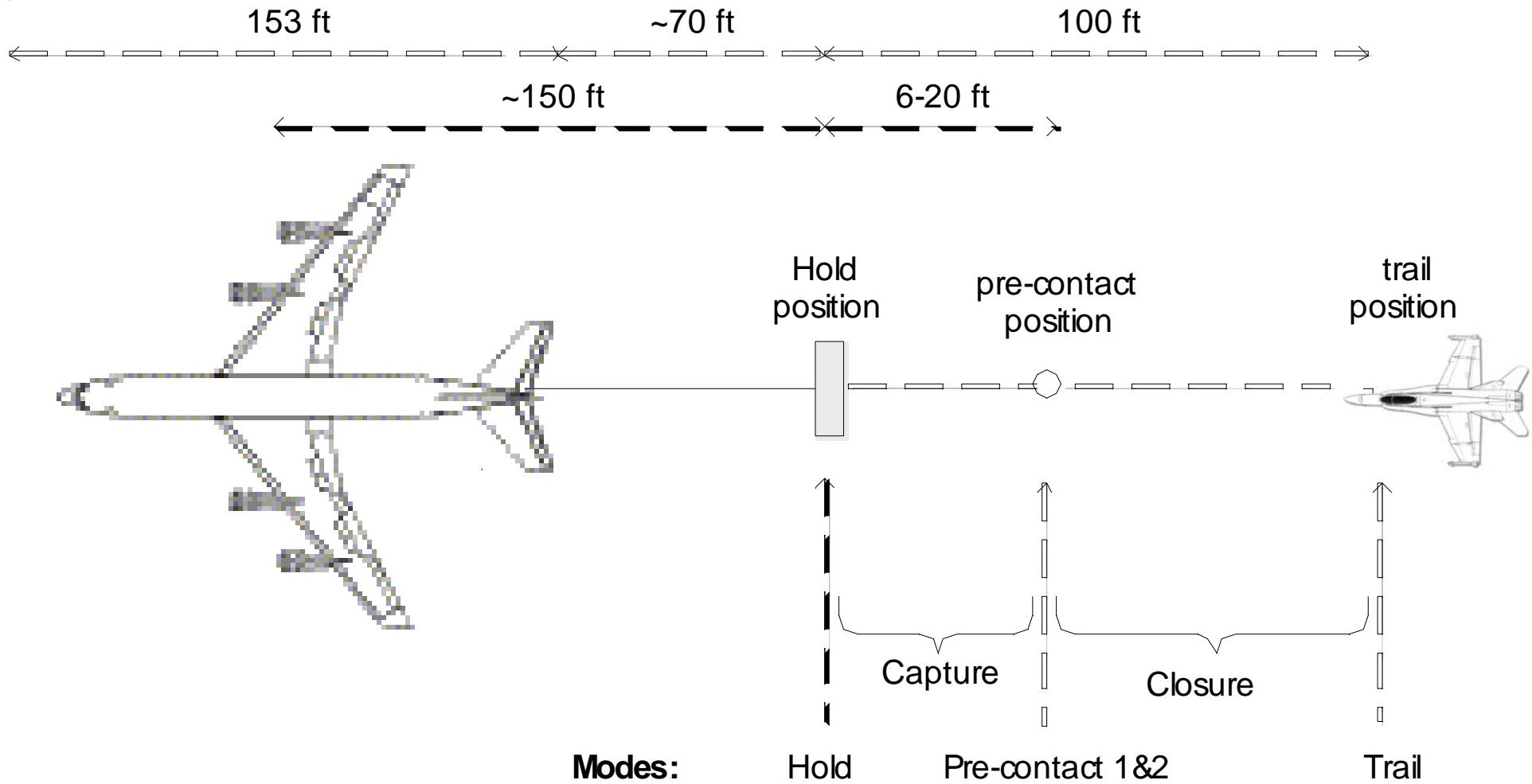


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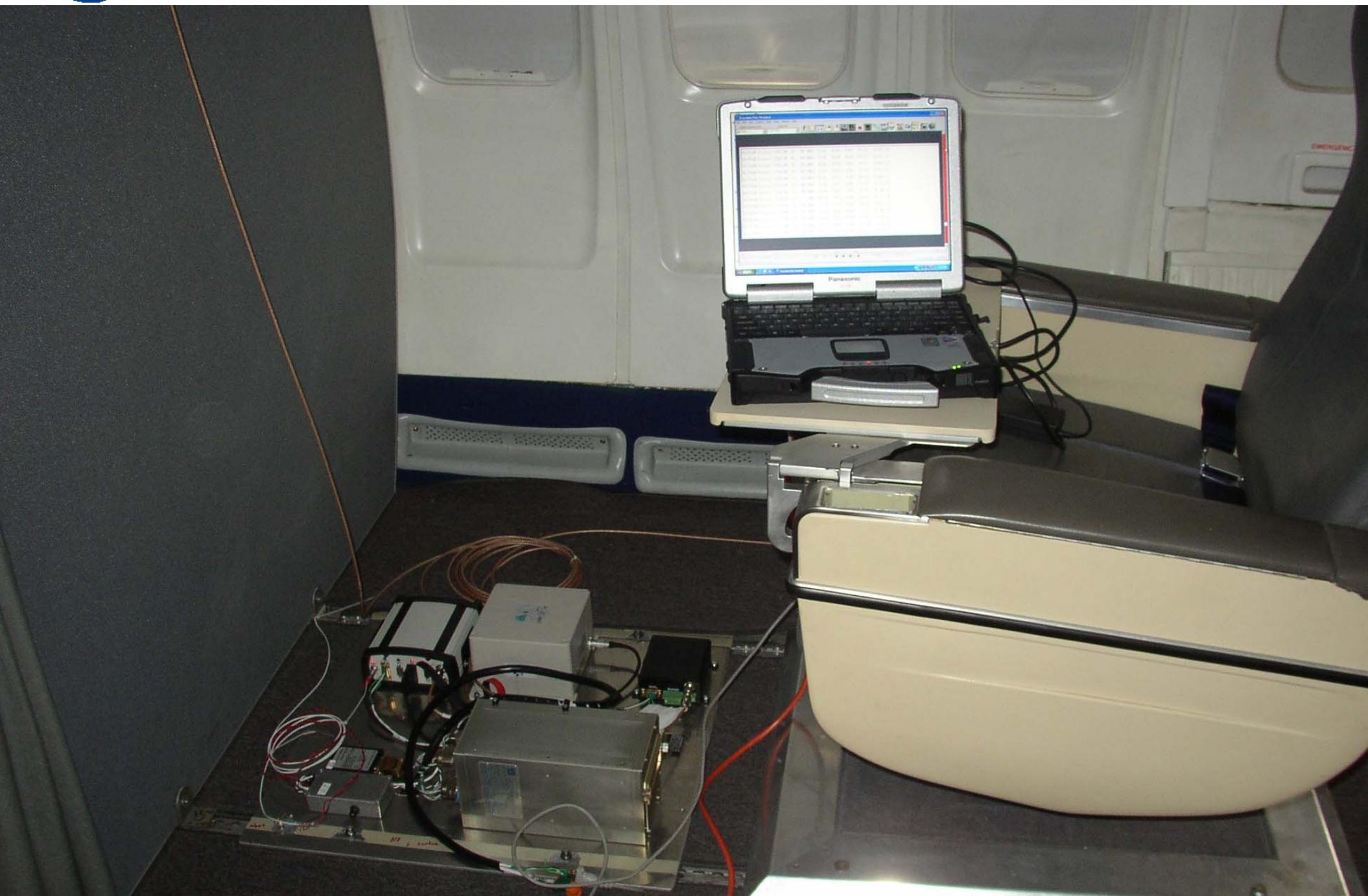


# Pictorial View





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# AARD Controller





# Rear Cockpit PVI





# PVI Controller

- Eight active push tiles with information

Stndby

Close

X: xxx  
Y: xxx

Z: xxx

Forcef  
Off

Manual

AARD  
OK

Trail



# Front Cockpit

- Canopy bow status lights
- Optical tracker camera
- Video selector
- DDI RFCS control





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# Validation Flights

- 4 Flights with Sabreliner Surrogate Tanker: 16 – 29 June 2006
- 3 Flights with Sabreliner in second phase: Nov 2006 – Mar 2007



# Omega Tanker Flights

## ➤ 9 Flights with Omega tanker:

- ⇒ 11 July '06: Optical tracker problems
- ⇒ 27 July '06: Optical tracker problems
- ⇒ 17 Aug '06: Data Link problems, Optical tracker OK
- ⇒ 30 Aug '06: **SUCCESS**
  
- ⇒ 13 Dec '07: Plugs
- ⇒ 22 Feb '07: Plugs in a turn
- ⇒ 23 Mar '07: Plugs in turbulence
- ⇒ 16 Apr '07: Plugs in turbulence
- ⇒ 17 Apr '07: Plugs in turns





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4-089-31 E-089-38 8-027-871: ANDI TM09 T P9 F14093

BACD: MTT-B1 MIZZARD

2015-07-31-039



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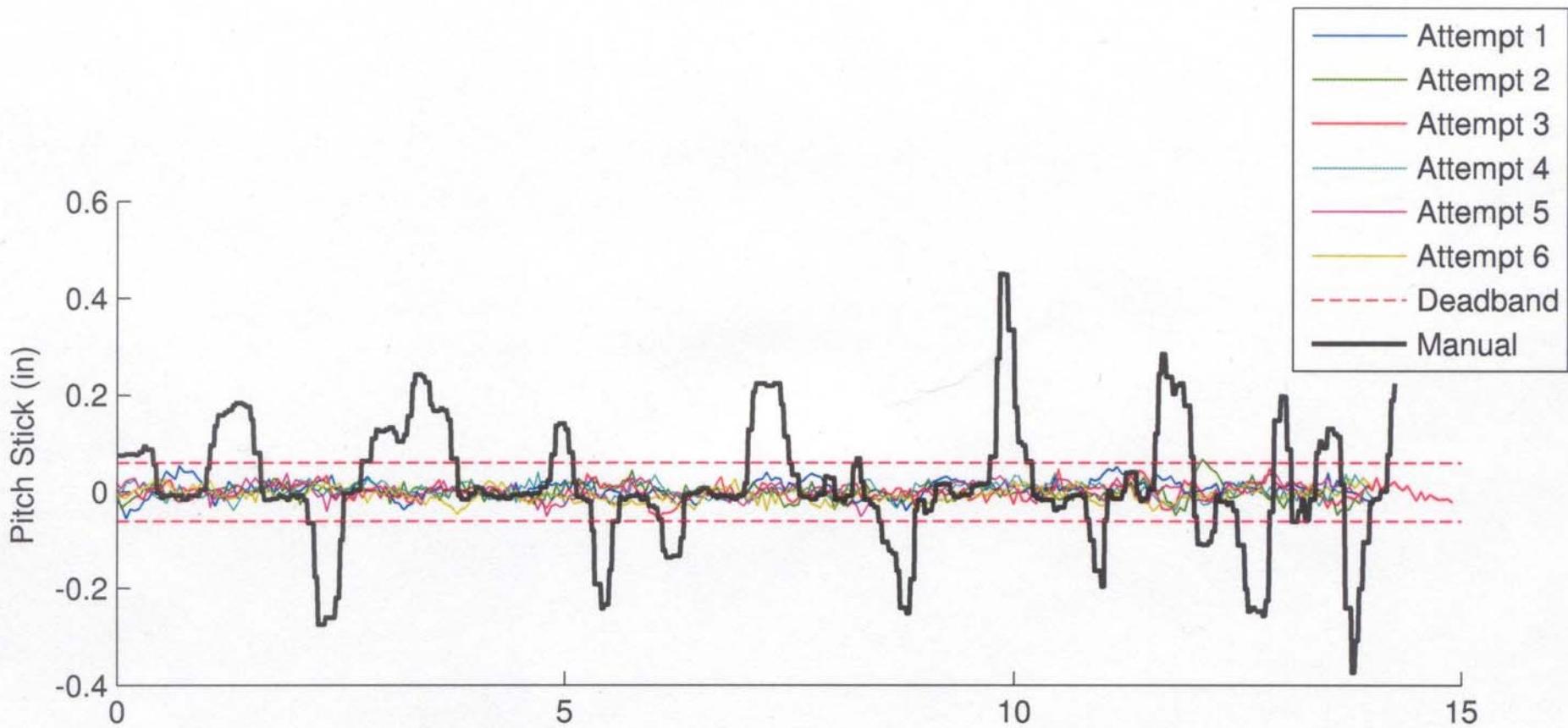
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# Turbulence





# “Stick” Measurements





# Lessons Learned

- **Early Pilot Involvement**
- **Computers Remove “Human” Problems**
- **Shortcuts Seldom Work**
- **“SHIT” Happens: (*S*oftware / *H*ardware *I*nduced *T*rauma)**



# Possible Users





# Questions???







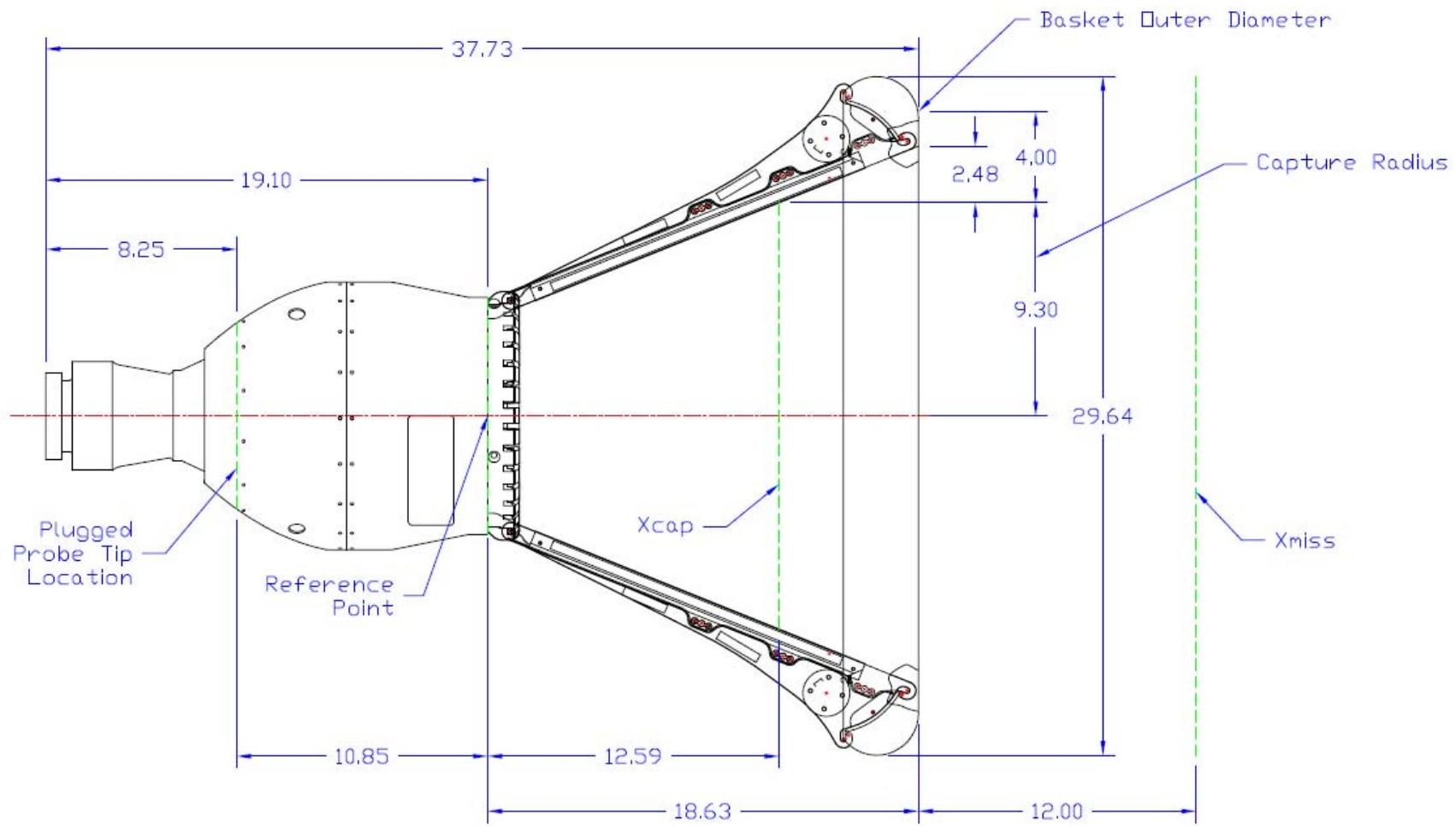
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A-013.82° E+003.74° R+136.77ft AM02 TM10 S P0

N

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U

BACIE MTT-B1 TRK:AARD

200-17-30-05-206





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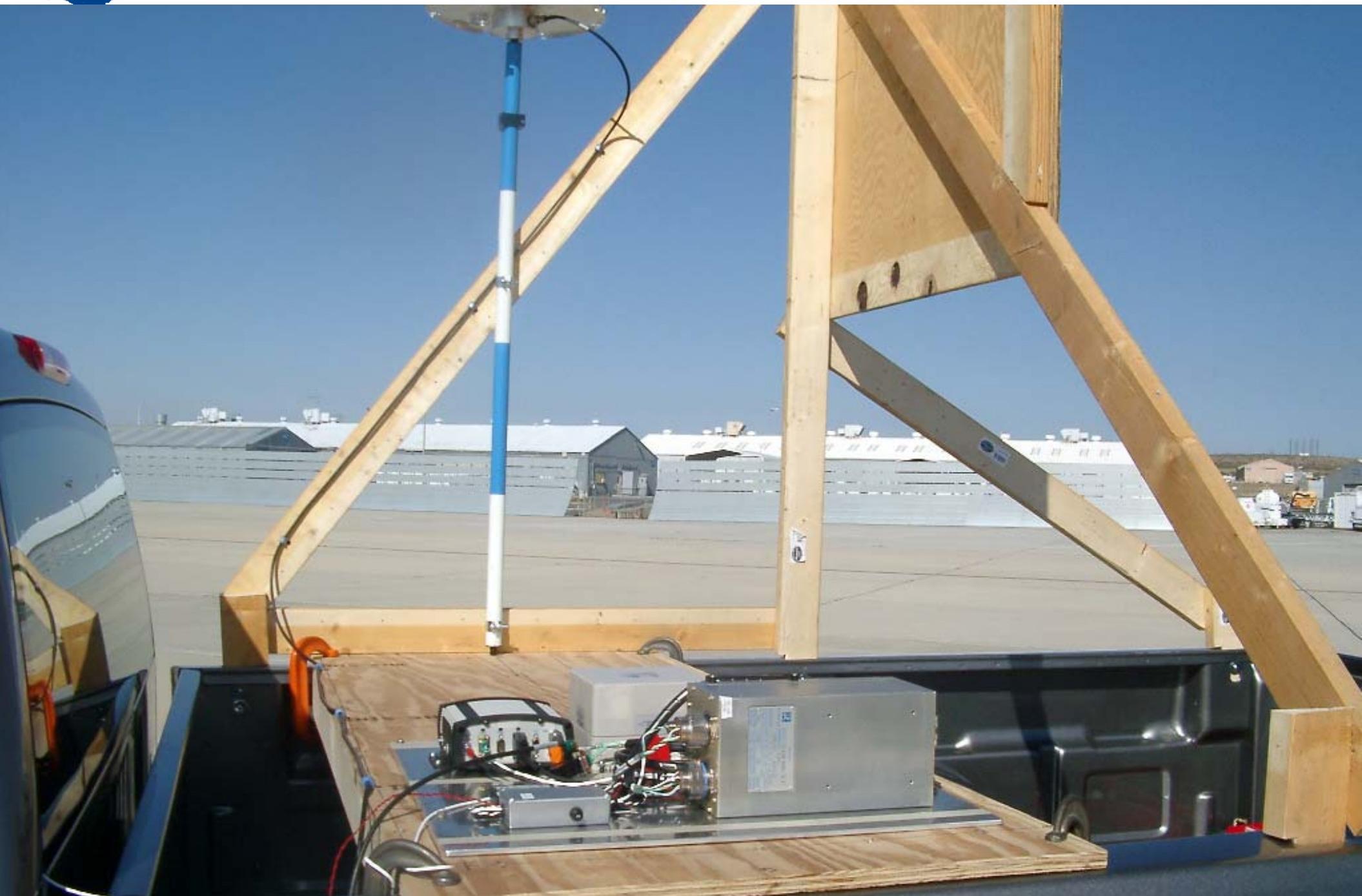


# PSFCC's





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A-004.25° E+000.56° R+030.83ft AH03 TH30 T P0 F44



BACQ: MTT-B1 UNKWARD

208:17:09:13.022



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# Front Cockpit Glareshield





06/07/2006

A-005.53° E-002.40° R+016.107 AN03 TH30 T FO F3II





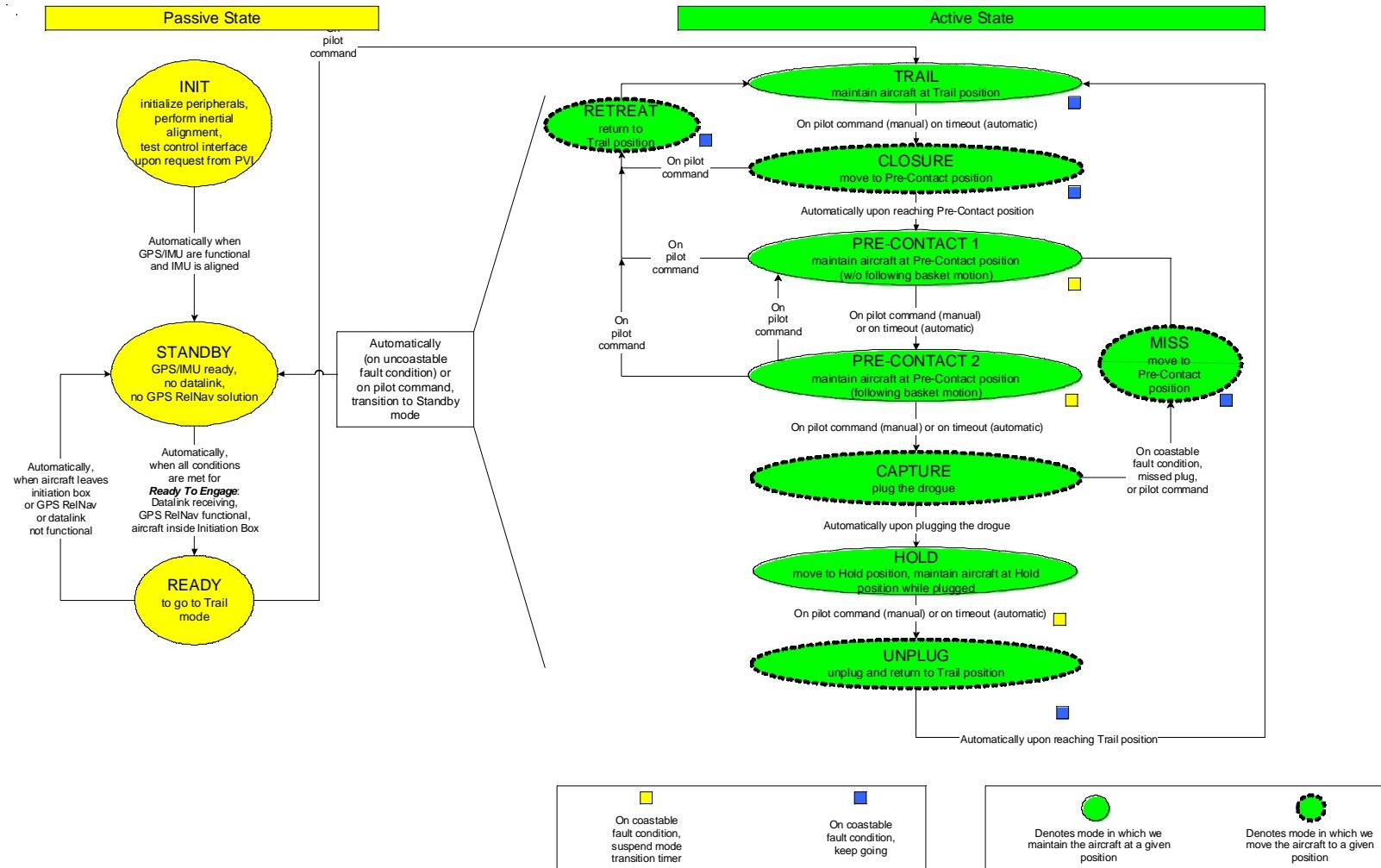
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# Receiver States and Modes





# AARD Test Program

- Background
- Participants
- Design
- Simulation and Ground testing
- Test Flights:
  - ⇒ With surrogate tanker
  - ⇒ With Omega tanker
    - Optical system problems
    - Rel-Nav problems
- 30 August 2006

